MOTOROLA INC. COMMUNICATIONS DIVISION • **INSTRUCTION MANUAL**

[redacted]

MOTOROLA PRECISION INSTRUMENTS

1011 Frequency Standard

MODELS S1065AR AND S1066AR

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MOTOROLA

1011 FREQUENCY STANDARD

MODELS S1065AR AND S1066AR

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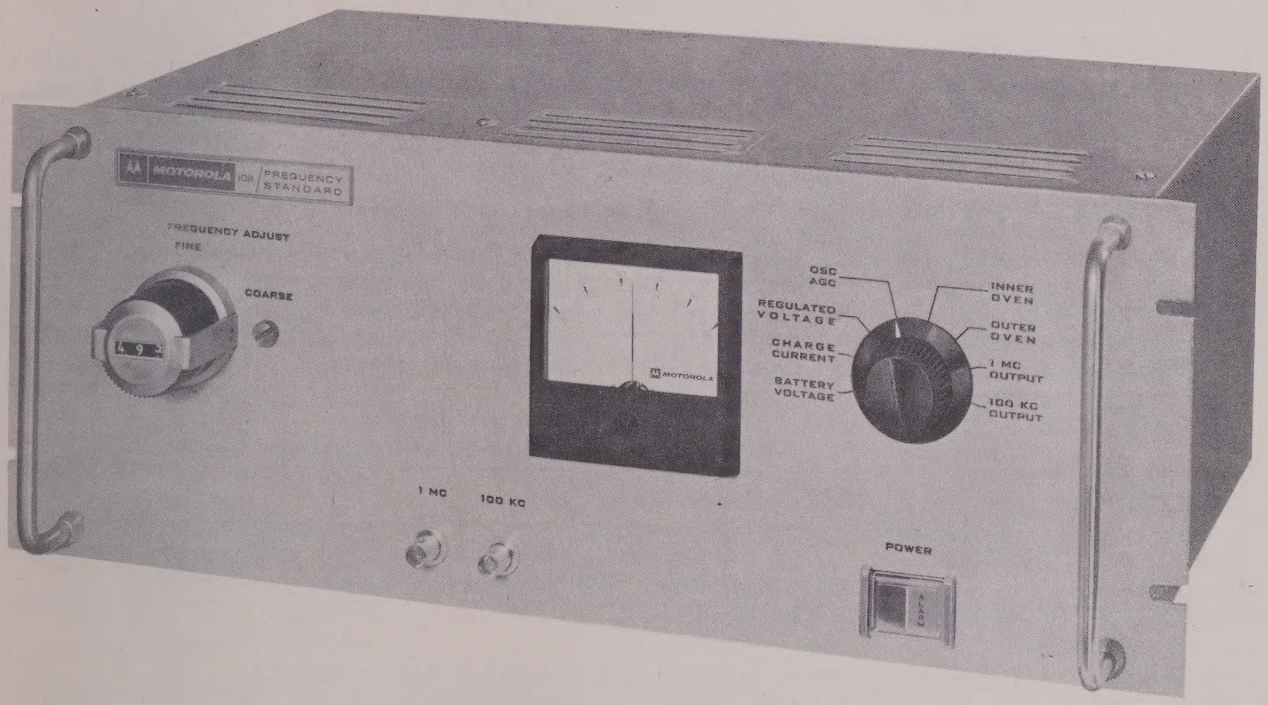

MODEL S1065AR/S1066AR FREQUENCY STANDARD

MOTOROLA INC.
COMMUNICATIONS DIVISION
Engineering Publications
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Chicago 51, Illinois

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Issue - A

GUARANTEED PERFORMANCE SPECIFICATIONS

FREQUENCY STANDARD MODELS	S1065AR and S1066AR
OUTPUT FREQUENCIES AND VOLTAGES	Model S1065AR: 1.0 mc; 1 volt rms into 50 ohm load 100 kc; 1 volt rms into 50 ohm load Model S1066AR: 5 mc; 1 volt rms into 50 ohm load (5 mc output is spectrally pure) 1 mc; 1 volt rms into 50 ohm load 100 kc; 1 volt rms into 50 ohm load
OPERATING TEMPERATURE RANGE	0°C to +35°C
Stability, $\frac{\triangle f}{f}$ max. versus:	
Input voltage ±10%	less than 1 part in 10^{10}
Load resistance ±10%	less than 1 part in 10^{10}
Ambient Temperature:	
20°C; +15°C -20°	within ±1.5 parts in 10^{10}
On Special Order:	
20°C; ±20°	within ±2.0 parts in 10^{10}
Short Term - 1 second samples	less than 5 parts in 10^{11} rms
Long Term - (after 4 wks)	less than 5 parts in 10^{11} per day (averaged over 10 days)
INPUT VOLTAGE	115/230 v a-c, ±10%, 50-400 cps, or 28-40 v d-c, 10 watts
DEMENSIONS	7" high x 19" wide x 12" deep
WEIGHT	30 lbs., with 15 hour battery pack 45 lbs., with 30 hour battery pack
CONNECTORS	BNC type
FREQ. ADJUSTMENTS	Coarse - 5 parts in 10^7 min. (screwdriver adj.) Fine - 1000 parts in 10^{11} indicating parts in 10^{11}

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FOREWORD

CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications &
Electronics, Inc.
Precision Instruments Department
4501 West Augusta Blvd.
Chicago 51, Illinois

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

REPAIR AND/OR RECALIBRATION

If desired the instrument may be returned to:

Motorola Communications &
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Precision Instruments Department
4501 West Augusta Blvd.
Chicago 51, Illinois

for repair and/or recalibration. Before shipping the instrument notify the Precision Instruments Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

SHIPPING

The instrument should be surrounded by two on three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via Truck, Railway Express, Air Freight, or Air Express.

WARRANTY

Motorola instrument equipment other than tubes, fuses, vibrators, and batteries is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

Tubes and vibrators carry their own standard manufacturer's warranty of 90 days or 1000 hours, whichever first occurs.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault developes, the following steps should be taken:

1. Notify us at the following address:

   Motorola Communications &
   Electronics, Inc.
   Precision Instruments Department
   4501 West Augusta Blvd.
   Chicago 51, Illinois

   Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

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1. INTRODUCTION

The 1011 Frequency Standard models are rack mounted, all solid state instruments that provide highly stable output frequencies. The Model S1066AR Frequency Standard provides outputs of 1 mc, 100 kc and a spectrally pure 5 mc output; whereas, the Model S1065AR provides outputs of 1 mc and 100 kc. The spectrally pure 5 mc output is obtained from the Model S1066AR Freqency Standard by using a crystal filter to limit the bandwidth to less than 30 cycles.

Stability is maintained over a wide range of input voltages and ambient temperatures by having the crystal oscillator in a double oven. Both ovens are proportional controlled. To insure continuous operation, and maintain frequency stability, nickel-cadmium batteries are employed in an arrangement such that failure of the a-c line voltage will automatically switch the frequency standard to battery power.

Loss of output signal and/or a-c line failure are indicated by lights on the front panel. Metering facilities provide for monitoring strategic voltages and currents within the standard.

2. DESCRIPTION

The frequency standards employ a 2.5 megacycle, fifth overtone quartz crystal housed with its complete oscillator circuitry in a double oven. Each oven utilizes proportional control. The proportional control circuitry is housed within the outer oven. (Refer to Block Diagram 69A81016A82.)

Precision glass piston capacitors are used for coarse and fine frequency adjustment of the oscillator. The coarse capacitor is housed within the inner oven, and is a screwdriver adjustment. A nylon tuning rod is brought out to the front panel to preclude capacitive effects of metallic tuning tools as well as to prevent possible oven temperature changes caused by the introduction of tuning tools into the oven. The fine frequency capacitor is mounted to the front panel and is adjusted by a 10-turn FREQUENCY ADJUST instrument dial. Fine frequency tuning range is 1000 parts in 10^{-11}, and indicates parts in 10^{11}.

The highly stable 2.5 mc oscillator output is multiplied to 5 mc and applied to a 5 to 1 regenerative divider which produces the 1 mc output signal. The 1 mc signal is also coupled to a 10 to 1 regenerative divider to produce the 100 kc output signals. Isolation is provided between the 1 mc output and the 1 mc signal coupled to the 10 to 1 divider. The 1 mc and 100 kc output signals are available at the front and rear of the unit through BNC connectors.

The spectrally pure 5 mc output of the S1066AR is derived by coupling a signal from the 2.5 to 5 mc multiplier stage into an amplifier and crystal filter module. The output is available at the rear of the unit through a BNC connector.

Loss of the 100 kc output signal is indicated by a red ALARM lamp on the front panel. The lamp will remain on during and after loss of signal, until it is manually reset. Receptacle contacts at the rear of the unit provide circuit connections to operate a remote failure alarm indicator.

Indication of a-c power failure and switchover to the rechargeable nickel-cadmium batteries in the unit is provided by the indicator lamp on the front panel. The lamp is on continuously while a-c is applied and becomes a flashing lamp during battery operation. Normal operating life of the batteries supplied with the frequency standard, as shipped from the factory, is 15 hours. An optional kit is available for increasing emergency battery operation to 30 hours. When the unit is operated from the a-c line, batteries are continuously on a trickle charge. Receptacle contacts at the rear of the unit provide circuit connections to use an external 28-40 volts, d-c source instead of 115-230 v a-c source.

3. INSTALLATION

a. Inspection

Unpack the unit and inspect the equipment for any shipping damage as detailed on Page iii in the front of this manual. The frequency standard is intended for installation in a 19-inch rack and for operation from a 115/230 v a-c primary power source.

b. 115 V AC Operation

(1) Connect the a-c line cord to a 115 volt, 50-400 cycle, a-c convenience outlet. The POWER indicator lamps on the front panel will light. The use of an exclusive 24-hour a-c line will protect the unit from accidental shutdown during nonworking hours and from power failures resulting from temporary overloads by other equipment.

(2) Connect the batteries by installing the 0.5 ampere, slow-blow fuse that is supplied separately in the BATTERY fuse receptacle at the rear of the chassis.

(3) To determine that the unit is functioning properly, perform the following metering checks:

METER SWITCH POSITION	METER READINGS INITIALLY	METER READINGS AFTER 2 HOURS
BATTERY VOLTAGE	36-44	36-44
BATTERY CURRENT	5 (15 hr. batteries)	5
	10 (30 hr. batteries)	10
REGULATED VOLTAGE	22-24	22-24
OSC. AGC	20-25	20-25
INNER OVEN	27-40	5-10
OUTER OVEN	27-30	5-25
1 MC OUTPUT	10-30	10-30
100 KC OUTPUT	10-30	10-30

(4) After meter readings have been established as normal, depress the red ALARM RESET button on the rear of the unit. The ALARM lamp on the front panel will turn off and the POWER lamp will remain illuminated. To verify that the batteries are connected and operating properly, disconnect the a-c line and check that the POWER lamp on the front panel begins flashing after a short interval.

c. 230 V AC Operation

CAUTION

Before operating the frequency standard from 230 volts, a-c, refer to the following instructions.

(1) As shipped from the factory, the transformer primary is connected to its associated terminal board as shown in Fig. 1 on Primary Power Circuit Diagram AEPD-8391, for 115 v a-c operation. For 230 v a-c operation, perform the connections shown in Fig. 2 on the same diagram.

(2) Connect the a-c line cord to a 230 v a-c convenience outlet. The POWER lamps on the front panel will light.

(3) Proceed with steps (2), (3) and (4) in paragraph 3.b.

d. External DC Operation

If external d-c operation is desired, connect a 28-40 volt, d-c source to pins A and H of the ACCESSORY receptacle, J7 at the rear of the unit. Power input should be 20 watts for initial warmup; 10 watts maximum for continuous operating power at room temperature.

e. Output Connections

1 MC OUTPUT: Parallel BNC connectors are located at the front and rear of the unit and will supply one volt rms into a 50 ohm resistive load.

100 KC OUTPUT: Parallel BNC connectors are located at the front and rear of the unit and will supply one volt rms into a 50 ohm resistive load.

5 MC OUTPUT: A BNC connector located at the rear of the Model S1066AR Frequency Standard will supply one volt rms into a 50 ohm resistive load.

f. Stabilization Period

The stabilization time required for the unit is between two and four weeks, depending upon the length of turn-off time. At the end of this period, the aging rate will be less than 5 parts in 10^{11} per day, averaged over a ten-day period.

g. External Alarm

An external, remotely located 100 kc loss indicator can be connected to pins B and E of the ACCESSORY receptacle, J7. During normal operation of the frequency standard, a nominal +4 volts will be present at pin B. During a 100 kc failure, the voltage at this terminal will be approximately +20 volts, d-c. However any external alarm connected must have a load resistance sufficiently high (20K ohms minimum) to prevent load current from reducing the available "alarm-

on" d-c potential. A nominal 1 ma can be drawn from this source (pin B) without hampering normal alarm circuit and alarm lamp operation. Typically, an external relay can be used to sense the failure indication at the remote point and, in turn, operate a self-powered alarm indicator device.

4. OPERATION

Once primary power and output connections are made and meter readings are found to be normal, the unit will require no attention except for periodic checks. The various indicators, controls and receptacles are described in the following paragraphs.

a. Output Connectors

(1) 1 MC BNC connectors are parallel connected and located at the front and rear of the unit. They will supply one volt rms into a 50 ohm resistive load. These output connectors can be short-circuited without affecting the 100 kc output because of a 1 mc isolation amplifier.

(2) 100 KC, BNC connectors are parallel connected and located at the front and rear of the unit. They will supply one volt rms into a 50 ohm resistive load.

(3) A 5 MC BNC connector is located at the rear of the S1066AR Frequency Standard. It will supply 1 volt rms into a 50 ohm resistive load.

b. Indicator Lamps

The two indicator lamps are located on the front panel in a split bezel indicator assembly. The left half indicates a-c or battery operation while the right half, with the word ALARM marked on the lens insert, indicates loss of the 100 kc output signal.

The left half indicates that the unit is being powered from an a-c source, when lighted. When a-c power is removed the steady light will begin flashing to indicate the loss of a-c power and also that the switchover to internal batteries has occurred. The light will continue to flash until the batteries are discharged, at which time the light will go out, or until a-c power is reapplied and the light again becomes steady.

The ALARM portion will normally be unlighted. However, should the 100 kc output signal be interrupted for any reason, this portion will light, and remain on until the 100 kc signal returns and the ALARM RESET button is depressed.

The 100 kc output detector (ALARM) can indicate for several reasons. First, obviously, the 100 kc divider may malfunction. Second, the 1 mc divider may malfunction and provide no input to the 100 kc divider. Third, the crystal oscillator circuitry may malfunction, and last there may be a power supply interruption or failure. It should also be pointed out that a short circuit applied to the 1 mc output will not cause a failure in the 100 kc output signal. Presence of the 100 kc signal can be determined from the meter reading on the front panel.

Another fault which would energize the ALARM light would be failure of the battery protection relay to be energized.

c. TEST Switch

This black pushbutton switch is located at the rear of the unit and provides a check on the "alarm" circuitry in the unit. When the switch is momentarily pressed and the ALARM lamp on the front panel is lighted, it is an indication that the "alarm" circuitry is functioning properly.

d. RESET Switch

This red pushbutton switch is located at the rear of the unit and extinguishes the ALARM lamp after the circuit malfunction that caused the lamp to turn on, has been repaired.

e. FINE Frequency Adjust

The FINE Frequency Adjust dial knob located on the front panel provides 1000 parts in 10^{11} frequency change with digital indication of 1 part in 10^{11}. Increasing digits produce an increasing frequency. The dial has a linear range between 000 and 999. A change of 10 dial divisions will produce a frequency change of 10 ± 2 parts in 10^{11}. A change of 500 dial divisions will produce a frequency change of 500 ± 20 parts in 10^{11}. If an orange square appears in the first window on the left of the dial, it indicates that the linear range of the trimmer has been exceeded. If further change of frequency is desired, the COARSE adjust control must be used.

f. COARSE Frequency Adjust

The COARSE frequency adjustment for the oscillator is accessible from the front panel by

removing the knurled knob below the word COARSE. Before adjusting this control, the FINE frequency adjust control should be rotated to 900 if the oscillator was aging upward, or to 100 if the oscillator was aging downward. The COARSE frequency adjustment is made by inserting a small blade screwdriver in the hole located under the removed knurled knob. Rotation of the trimmer in the counterclockwise direction increases frequency; rotation in the clockwise direction decreases frequency.

g. METERING Switch

The eight-position switch on the front panel provides monitoring of vital circuits in the unit and displays the reading on the front panel meter. The various circuit checks available are as follows:

(1) BATTERY VOLTAGE: This switch position meters the battery voltage. When a-c is applied to the unit, it indicates the d-c voltage available at the input to the constant voltage and constant regulator circuitry in the power supply. When the unit is operating on batteries, it provides a direct indication of battery voltage input to the constant voltage regulator.

(2) CHARGE CURRENT: This switch position meters the battery charging current. If a 15 hour type battery pack is used, the meter reading should be 5; if the 30 hour type battery pack is used, the meter reading should be 10. A fixed resistor (R59) in the constant current regulator circuit establishes the charge rate. Since the amount of charging current is critical, the value of the fixed resistor is factory selected depending upon the type of battery pack supplied with the unit at time of shipment.

(3) REGULATED VOLTAGE: This switch position meters the constant voltage regulator output voltage. A meter reading between 22 and 24 should be obtained, and remain constant in a given unit.

(4) OSC. AGC.: This switch position meters the agc voltage that is applied to the oscillator. A meter reading of 20 to 25 should be obtained.

(5) INNER OVEN: This switch position meters the current in the inner oven heater winding. A meter reading between 25 and 45 should be obtained during warmup; a reading between 5 and 10 should be obtained after warmup.

(6) OUTER OVEN: This switch position meters the current in the outer oven heater winding. A meter reading between 27 and 30 should be obtained during warmup; a reading between 5 and 25 should be obtained after warmup, depending upon the ambient temperature.

(7) 1 MC OUTPUT: This switch position meters the amplitude of the 1 mc signal. When the output is properly terminated in a 50 ohm resistive load, a meter reading between 10 and 15 should be obtained.

(8) 100 KC OUTPUT: This switch position meters the amplitude of the 100 kc signal. When the output is properly terminated in a 50 ohm resistive load, a meter reading between 10 and 15 should be obtained.

h. OSCILLATOR DISABLE Switch

This switch is used to disable the oscillator for test purposes, by removing d-c voltage from the oscillator without disabling the oven circuits. This switch should not be used as an operational control because each time the oscillator is disabled, a warmup time somewhat proportional to the turn-off time will be required.

5. THEORY OF OPERATION

a. Introduction

The frequency standard models consist of the following major items:

(1) Crystal
(2) Oscillator
(3) Divider Circuitry
(4) 5 MC Amplifier and Crystal Filter (p/o S1066AR)
(5) Inner Oven
(6) Outer Oven
(7) Power Supply
(8) Alarm Circuit

Each of these items will be discussed in detail with respect to its contribution to the performance of the unit. (Refer to Block Diagram 69A81016A82 in this manual.)

A 2.5 mc, fifth overtone crystal was selected as being best suited to provide good stability and low aging over a long period of time. A transistor oscillator employing stabilized circuitry and constant, low drive level for the pre-

cision crystal is used to ensure the utmost in performance. Buffer amplifiers guarantee isolation of the oscillator circuitry from external load effects. A high-gain, proportional-control inner oven circuit maintains the crystal and oscillator circuitry at a predetermined temperature to within a fraction of a milli-degree. A similar outer-oven control circuit maintains the temperature of the inner oven assembly as well as the entire oven circuitry to within a small fraction of a degree. The effects of ambient temperature changes on the circuits contained in the ovens is thus greatly reduced.

Fail-safe divider circuits produce the desired 100 kc and 1 mc output frequencies. A power supply incorporating a temperature-compensated, highly-stable, solid state regulator is used to eliminate the effects of voltage variations on the output frequencies. Nickel-cadmium batteries are employed for standby operation and are connected to immediately power the unit in the event of a power failure. The charging current for these batteries is provided by the power supply.

b. Crystal

The crystal resonator is characterized by high Q, low temperature co-efficient of frequency at the operating temperature, and low co-efficient of frequency with current as well as low aging tendencies. The 2.5 mc crystal exhibits a series resonant resistance of approximately 65 ohms and an inductance of 19.5 henries resulting in an approximate Q of 4×10^6. The zero temperature co-efficient of frequency lies between +47°C and +57°C, thus the actual temperature co-efficient in the region of "turnover" is less than 1 PP10^9 per centigrade degree.

The current co-efficient of frequency is held below 1 PP10^9 per db when currents less than 100 microamperes are employed. The resonator operates with currents between 30 and 50 microamperes. Operation with larger currents results in rapidly increasing frequency shifts with current changes while, on the other hand, operation at currents much less than 30 microamperes produces poor signal-to-noise ratios.

c. Oscillator

The oscillator circuit consists of a transistor oscillator followed by four stages of amplification. The r-f level at the last stage is detected by a pair of diodes. The resultant d-c voltage is amplified and returned to the oscillator transistor as bias, thus forming an automatic gain control loop.

The object in the design of high-stability oscillator circuits is to maximize the ability of the crystal to have complete control of the operating frequency. Because the oscillator must contain an active element, such as a transistor, as well as various reactances, it is mandatory that the effect of these circuit components upon frequency be minimized. This is done by choosing an oscillator circuit in which there are no tuned circuits in which the input and output circuits of the active element are shunted by large capacitances to keep variations in the capacity of these circuits inconsequential.

The oscillator transistor (Q101) parameters are relatively temperature and age insensitive. It operates at extremely low power levels with very low noise, since noise contributes to short-term instabilities. Furthermore, it has a high ratio of maximum frequency to operating frequency to ensure little phase-shift through it. Changes in phase-shift due to aging and other variations consequently are also small.

The coarse and fine frequency adjustments, C107 and C45, are also associated with the oscillator. Glass piston capacitors are used to provide these frequency changes because of their good linearity, resetability, and low temperature co-efficient.

Buffer amplifier stage, Q102, also uses a very low noise transistor because of the very low signal level it must handle. This stage is direct coupled and has no tuned circuits connected to it, thus isolating the oscillator from reactance changes.

Both these stages (oscillator and buff r amplifier) are NPN silicon transistors with extremely good noise characteristics. The last three stages (Q103, Q104, Q105) in the oscillator circuit serve to amplify the signal to a usable level as well as provide a high degree of isolation.

The detector diodes CR101 and CR102 are quick-recovery diodes which rectify a small amount of the signal and apply it to the base of Q106 where it is amplified, producing AGC for the oscillator transistor Q101. The AGC level is adjusted so that the crystal current is between 30 and 50 microamperes. It is maintained between these very narrow limits by virtue of the stabilized circuitry and rigid temperature control. A controlled amount of negative feedback

is applied to the amplifier stages by means of partially by-passed emitters. This is to stabilize the overall loop gain at the transistor gains change slowly over a long period of time.

Operating voltage for the oscillator circuits is nominally 15 volts, d-c which is applied via pin J of connector P2, through dropping resistor R35. Pin A of connector P2 is ground for the oscillator circuits; pin B of this connector provides connection of oscillator AGC voltage to the front panel for metering. Connector P2 has a locking ring to prevent accidental oscillator disconnect from the chassis cabling.

d. Divider Circuitry

The 2.5 mc to 1 mc divider consists of a x2 multiplier, Q1; mixer, Q2; x4 multiplier, Q3; and output amplifier, Q4. No output can be obtained from the divider without input.

Transistor Q1 and its tuned collector circuit, consisting of L1, C2 and C3, serve to multiply the 2.5 mc input to 5 mc and inject it into the emitter of mixer, Q2.

Initially, application of the input signal produces ringing in the tuned circuits of the mixer and x4 multiplier which then provides the required 4 mc signal at the base of mixer Q2.

The 5 mc emitter input from Q1 and the 4 mc base signal from Q3 are mixed by Q2 and the 1 mc difference frequency is selected in the collector tuned circuit. The tap at C4 and C5 then supplies 1 mc to the x4 multiplier, Q3, to sustain generation of the 4 mc mixer input.

The junction at C5 and C6 in the collector circuit of Q2 supplies 1 mc output to the next divider (1 mc to 100 kc) and to the front and rear panel BNC connectors via amplifier Q4. This amplifier is used to prevent 1 mc output loading from affecting performance of the divider as well as to provide proper output impedance. A short circuit placed across the 1 mc output will not effect the performance of the divider.

Diode CR1 and capacitor C18 supplies a DC voltage to the metering circuitry on the front panel of the unit for an indication of the presence of the 1 mc signal.

The 1 mc to 100 kc divider functions essentially as does the preceding divider. A 1 mc input to Q5 is amplified and passed on to mixer; Q6. A synthesized 900 kc is obtained from x9 multiplier Q7. Mixer inputs of 1 mc from Q5 and 900 kc from Q7 result in a difference frequency of 100 kc being selected in the tuned circuit consisting of L8, C22, C23 and C24. The 100 kc from Q6 is returned to the x9 multiplier to sustain generation of 900 kc.

Mixer output is also coupled to amplifier Q8. From the tuned collector of the isolation amplifier, 100 kc is made available to the parallel-connected front and rear panel BNC output connectors.

Metering of the 100 kc output is performed by rectifying a portion of the signal at CR2 and supplying it to the panel meter via metering switch S4.

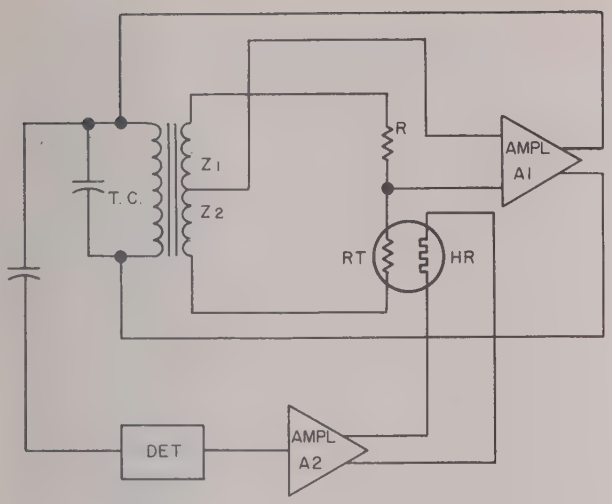
e. 5 MC Amplifier and Crystal Filter

A 5 megacycle signal from the x2 multiplier, Q1, on the 2.5 mc to 1 mc divider is fed to amplifiers Q301 and Q302. The amplified 5 mc output signal is applied to AGC amplifier Q303 and the resultant output is filtered by the circuit consisting of Y301, C311, C312 and C313 which has a bandpass of approximately 30 cycles. The output of the filter is amplified by Q304 and coupled to receptacle J9 via double-tuned output circuits.

The output signal level at receptacle J9 is regulated by rectifiers CR301 and CR302 which supply an AGC control voltage to amplifier Q303.

f. Inner Oven

To maintain the crystal and that portion of the oscillator circuit closely coupled to the crystal electrically at a precisely constant temperature, it is necessary to employ a stable, high-gain proportional-control oven circuit as shown in the following simplified diagram. The tuned circuit (TC) which is coupled to the output of amplifier, A1, drives an a-c bridge consisting of impedance branches Z1 and Z2, as well as resistive branches R and TR (temperature dependent resistor). The output of the bridge is subsequently connected to the input of A1 such that positive feedback occurs when the bridge is unbalanced. The oscillations resulting are detected (DET), amplified by a d-c amplifier, A2, then fed to a heater winding, HR. These conditions prevail until the bridge approaches balance, which is brought about by TR being elevated to a specific temperature such that $Z1/Z2 = R/TR$. If the temperature attempts to rise above the bridge balance condition, the bridge feedback phase changes 180° so that negative feedback occurs and no oscillations can take place.



Proportional Control Oven Circuit
Simplified Diagram

The temperature of the oven is set by adjusting the value of R, making the balance condition possible over a range of temperatures. Since the 2.5 mc fifth overtone crystals used may have "turnover" temperatures from 47°C to 57°C, the oven temperature is capable of being set to not more than 0.1°C from the crystal turnover temperature with no more than 1 part in 10^{10} frequency change.

The high-gain control circuit utilizes silicon NPN transistors because of their inherently low leakage currents and good reliability.

g. Outer Oven

To further ensure that changes in temperature of the inner oven are minimized, an outer oven is employed which maintains these circuits to a fraction of a degree as the ambient varies. Ambient range of the inner oven is thus greatly restricted, improving crystal stability by not having to follow temperature changes with heat surges.

In order that gain changes in the inner oven control circuit do not change with temperature, is placed inside the outer oven along with the outer oven control circuit.

The method of control and the circuitry of the outer oven are similar to those of the inner oven. The temperature of the outer oven is set slightly below the inner oven temperature.

h. Power Supply

The frequency standard operates from a 50 to 400 cps, single-phase primary source of 115/230 volts, a-c ±10%. The power supply delivers +22 v d-c from an electronic regulator with capacity sufficient to operate the oscillator-divider unit. The power supply also delivers sufficient power to charge standby batteries through a constant current charging circuit. The standby batteries are floated across the electronic regulator input so that in the event of primary power failure the battery supply automatically provides power to the electronic regulator without interruption.

Transformer T1 supplies primary a-c to the bridge rectifier consisting of CR5 thru CR8. Approximately 40 v d-c is impressed across filter capacitor C43 and applied to the regulator circuits.

Transistor Q16 (2N1489) functions as a series current regulator, and Q14, Q15 and Q17 to sense and regulate output voltage. Zener diodes CR13 and CR14, via Q17, establishes a fixed voltage reference level. Q17 utilizes this reference level at its emitter to sense power supply output voltage changes appearing across R56 and R57. DC changes at the base of Q17 are therefore amplified and, with Q17 collector tied to the base of Q15, changes the base voltage which results in a voltage change at the emitter of Q15. The emitter of Q15 is common with the base of series regulator Q16, and consequently controls the voltage drop across Q16.

Transistor Q18 is employed in a constant current battery charging circuit to provide a continuous charging current to the internal battery. DC voltage from the bridge rectifier provides for proper operating voltage and the value of resistor R59 is selected to supply collector currents consistent with charging requirements for 15 or 30 hour battery packs. Diodes CR19 and CR20 are biased with 40 v d-c on the cathode and 28.8 v d-c on the anode during normal a-c operation of the unit and no current can be drawn from the battery. Should a-c power fail, the cathode voltage is removed, the diodes conduct, and battery voltage is fed to the regulator circuits through the contacts of relay K1.

The frequency standard will operate normally from the internal batteries for the 15 or 30 hour periods depending upon the battery kit used. However, operation beyond these limits will result in battery voltage decreasing beyond a usable level and subsequent deterioration of the standard output signals. Since the 1 mc and 100 kc outputs can be expected to be unreliable at this time, and to prevent complete discharge from resulting in possible damage to the batteries, relay K1 and Zener diode CR22 are employed to sense battery d-c and to disconnect the batteries from further dis-

charge when the available voltage drops below 20 v d-c.

Relay K1 is normally held energized by d-c derived either from the bridge rectifier or (in the event of power failure) the internal batteries. Once the unit begins operating from the internal batteries K1 becomes self-holding via its contacts 4 and 5 and energizing current flows through the coil and the series connected Zener diode. When the available d-c from the batteries drops below 20 v d-c, Zener diode CR22 ceases conducting and relay K1 de-energizes, opening relay contacts 4 and 5 and disconnecting the batteries from further drain.

External d-c power can be used to operate the frequency standard as a primary source (instead of 115/230 v a-c) or as an emergency standby supply. In either event, internal batteries may be left in place. An external d-c source of 28-40 v d-c nominal can be connected to the unit at pins A and H on the ACCESSORY receptacle, J7. With the unit operating from an a-c line, diode CR21 is back biased by the power supply rectifier output. An a-c line failure removes the bias and operation of the unit will be from external d-c or internal battery, whichever voltage is greater.

Momentary short circuits across the power supply output will cause no damage to the unit. During a short circuit, load current is limited by design of the regulator to 750 ma. In addition slow-blow fuse F2 (0.6 amp) will not open for approximately 60 seconds. Removal of the short will return operation of the unit to normal.

Should the short persist for more than 60 seconds, fuse F2 will open, removing a-c input from the unit. The battery voltage will then be applied through relay K1 contacts to the regulator, but fuse F3 (0.5 amp) will immediately open from the over current load and remove power from the unit.

LINE fuse F1 and BATTERY fuse F3 are located at the rear of the frequency standard and are accessible from outside the unit. Fuse F2 is accessible by removing the bottom dust cover of the unit, and is located at the rear of the chassis immediately below the batteries.

i. Alarm and Power Indicator Circuitry

The alarm circuits consist of an a-c power detector and indicator and a 100 kc detector and indicator.

(1) POWER INDICATION CIRCUITRY: Rectified a-c voltage is taken from the output of the power supply bridge rectifier and applied to the base of transistor Q10 on the alarm circuit board. This voltage biases Q10 such that collector current flows continuously, illuminating the two series connected POWER indicator lamps which show on the front panel of the unit. During normal operation of the power supply, therefore, the POWER indicator will remain illuminated.

Loss of rectified a-c for any reason (removal of a-c power, failure in the power supply, etc.) results in the bias being removed from the base of Q10 and this stage, in conjunction with Q9, functions as a free-running multivibrator. Capacitors C37 and C38 are chosen to control the on-off cycle of the multivibrator. The resultant circuit operation provides for a flashing POWER lamp indication which denotes loss of a-c power for any reason and indicates operation of the standard is from internal batteries.

Loss of battery voltage after loss of a-c power removes the circuit voltage and the alarm multivibrator will not function at all. The POWER indicator will not be illuminated.

The restoration of a-c power to the unit (or correction of power supply failure) will automatically supply the bias voltage to Q10 of the multivibrator and inhibit further oscillation. This results in continuous illumination of the POWER lamp as an indication of normal operation.

(2) ALARM INDICATION CIRCUITRY: The alarm circuits consist of transistors Q11, Q12, Q13 and the two series connected ALARM lamps which provide an alarm indication on the front panel. Loss of the 100 kc reference frequency as monitored at the 100 kc output BNC connectors on the front and rear panels will activate the alarm circuits.

Loss of 100 kc may be caused by failure of any one of the following:

(a) 1 mc to 100 kc divider board

(b) 2.5 mc to 1 mc divider board

(c) Oscillator

(d) Improper setting of switch, Oscillator Disable S1.

(e) Direct short across 100 kc output BNC connector.

The presence of 100 kc at the input of emitter-follower stage Q11 places a control voltage on Schmitt Trigger stage Q12. The Schmitt Trigger (Q12 and Q13) is a voltage sensitive binary circuit. If a voltage is maintained at the input to the circuit equal to or greater than the triggering level, the circuit will have one stage conducting and the other stage cut off. The input voltage may very in magnitude, but until it again passes through the triggering level, no change will occur in the output. Once the input passes through the triggering level, the two stages reverse themselves with the previously cut-off stage going into conduction.

In the alarm circuit, Q12 is held in a conducting state by the presence of 100 kc at the emitter-follower stage Q11 and Q13 is held cut off by a combination of low base voltage and high emitter voltage. The ALARM lamps are not illuminated. Loss of the 100 kc changes the bias voltage of Q12 such that the base swings less positive (through the triggering level) cutting off Q12. This decrease in emitter voltage is accompanied by an increase in collector voltage, the combination of which allows Q13 to conduct, and collector current through the lamps illuminate the ALARM indication on the front panel.

Biasing on Q13 is such that will no input to the Schmitt-Trigger, Q13 will always be in a full conducting state. Even after restoration of the 100 kc, Q13 will remain conducting and the circuit must be reset manually with the Alarm RESET switch on the rear of the unit. The reset action momentarily opens the emitter of Q13, allowing Q12 to go into conduction and cut off Q13.

The alarm TEST push-button switch on the rear of the unit grounds the base of Q12 (when pressed), cutting off conduction and allows Q13 to illuminate the ALARM lamps as a check for proper operation of the Schmitt-Trigger. The Alarm RESET button must again be pressed to turn off the ALARM lamps and restore the alarm circuitry to normal operation.

j. Metering

Metering facilities are provided by 0-50 microampere meter M1, and selector switch S4 (on front panel) with associated series dropping resistors. Positions 1 and 3 connect the meter through high values of series dropping resistors to provide indications of power supply d-c voltages.

Positions 4, 7 and 8 of the metering switch are connected to signal sources through nominal values of series dropping resistors. The signal sources (oscillator AGC, 1 MC and 100 KC) use diode detectors to supply d-c voltages suitable for metering.

NOTE

Normal meter readings are listed in the INSTALLATION section of this manual.

Positions 2, 5 and 6 of the metering switch measure the voltage drops across key components in the battery charging circuit and the two oven/heater windings. For example, transistors Q203 and Q204 control current through heater winding HR201 and series connected resistor R211. When the oven is drawing heavy current, the voltage drop across R211 is large. The metering circuit which is connected across R211 indicates a voltage which is relative to the heater current. The normal range of expected meter readings for positions 2, 5 and 6 are also listed in the INSTALLATION section of this manual.

6. CALIBRATION AND ALIGNMENT

a. General

This instrument should be serviced by personnel qualified in maintaining laboratory test equipment. It is an accurate, sensitive device and should be treated as such. When qualified personnel or adequate test instruments are not available, the equipment should be returned to the factory for service or recalibration. Refer to the FOREWORD for detailed instructions.

The following table lists the necessary equipment for alignment and adjustment of the two divider modules and the 5 mc spectral purity module. Refer to top and bottom views of the unit (AEPD-8411 and AEPD-8412) for location of modules and components.

(1) Signal Generator (Measurements Corporation Model 82, or equivalent)

(2) Oscilloscope (Tektronix Type 545 w/CA Preamplifier, or equivalent)

(3) RF Voltmeter (Boonton Model 91CA, or equivalent - use when aligning S1066AR)

(4) A 50 ohm load

(5) A 0.01 uf capacitor

(6) A non-metallic tuning tool

b. Calibration

Periodic calibration of the oscillator should be made against an atomic frequency standard or with a VLF receiver frequency standard. Controls to be adjusted for this purpose are described in paragraphs 4.e. and 4.f.

c. Divider Alignment

During normal usage, the divider circuitry can be expected to perform reliably for considerable periods of time without the need for realignment. However, if for any reason electronic components are changed or the variable inductors are tampered with, realignment of the affected divider must be made.

Test equipment for this purpose should be of laboratory quality and subject to scheduled preventive maintenance and calibration. Of particular importance is the accuracy to which the required signal generator can be adjusted.

d. 2.5 MC to 1 MC Divider Alignment Procedure

(1) Remove the 2.5 mc coaxial cable connected between the oscillator and the 2.5 mc to 1 mc divider board. (Disconnect oscillator output at P1.)

(2) Connect the signal generator output, through a .01 uf capacitor to the 2.5 mc input of the divider board at receptacle P1.

(3) Connect a 50 ohm resistive load to the 1 mc output connector.

(4) Connect the vertical input of the oscilloscope to the emitter of Q2.

(5) Adjust the signal generator output frequency to 2.5 mc at a level of 0.15 volts, p-p.

(6) Adjust the slug of L1 for maximum vertical deflection on the oscilloscope.

(7) Connect the oscilloscope horizontal external sweep to the 50 ohm resistive load, and the vertical input to the base of Q1.

(8) Adjust the slugs of L2 and L3 until a 2.5 to 1 Lissajous figure is obtained on the oscilloscope. If enough output is not obtained to produce a usable Lissajous, the slugs of L4 and L6 may be adjusted.

(9) Vary the signal generator frequency from 2.5 to 2.55 mc and observe a smooth pattern for this range. If a smooth pattern is not obtained, re-adjust L2.

(10) Vary the frequency of the signal generator from 2.5 to 2.45 mc and again observe a smooth pattern for this range. If a smooth pattern is not obtained, re-adjust L3.

(11) Repeat steps 9 and 10 until divider operation is well centered and operates over the range of 2.45 to 2.55 mc.

(12) Connect the vertical input of the oscilloscope to the front panel 1 mc output receptacle. Set the signal generator for a 2.5 mc output.

(13) Adjust L4 and L6 for a maximum undistorted waveform on the oscilloscope. The output voltage should be at least 1.0 volt, rms.

(14) Disconnect the signal generator input cable and check for no output from the divider board, as observed on the oscilloscope.

(15) Reconnect the signal generator input cable. An oscilloscope pattern should now be observed as indication that the divider board is functioning.

(16) Reconnect the oscillator output cable to its receptacle P1. Repeat step 13.

e. 1 MC to 100 KC Divider Alignment Procedure

(1) Remove the 2.5 mc oscillator output to the 2.5 mc to 1 mc divider board at receptacle P1.

(2) Connect the signal generator output, through a .01 uf capacitor to the 1 mc to 100 kc divider input at the base of Q5.

(3) Connect a resistive (50 ohm) load to the 100 kc output connector.

(4) Connect the vertical input of the oscilloscope to the signal generator output.

(5) Connect the horizontal input of the oscilloscope to the 100 kc output connector.

(6) Adjust the signal generator output frequency to 1.0 mc at a level of 0.5 volts, peak-to-peak.

(7) Adjust the slugs of L8 and L9 until a 10:1 Lissajous figure is obtained on the oscilloscope. If the horizontal input to the oscilloscope is not large enough, adjust the slugs of L10 and L11.

(8) Vary the signal generator frequency from 1.0 to 1.02 mc and observe smooth divider operation for this range. If smooth operation is not obtained, re-adjust L8.

(9) Vary the signal generator frequency from 1.0 to 0.98 mc and observe smooth divider operation for this range. If smooth operation is not obtained, re-adjust L9.

(10) Repeat steps 8 and 9 until divider operation is well centered and operates smoothly over the range of 0.98 to 1.02 mc.

(11) Connect the vertical input of the oscilloscope to the front panel 1 mc output receptacle. Set the signal generator for a 1.0 mc output.

(12) Adjust L10 for a maximum undistorted waveform on the oscilloscope.

(13) Adjust L11 for a maximum undistorted waveform on the oscilloscope. The output voltage should be at least 1.0 volt, rms.

(14) Disconnect the signal generator input cable and check for no output from the divider board, as observed on the oscilloscope.

(15) Reconnect the signal generator input cable. An oscilloscope pattern should now be observed as indication that the divider board is functioning.

(16) Reconnect the oscillator output cable to its receptacle P1. Repeat steps 14 and 15.

f. 5 MC Amplifier and Crystal Filter Alignment Procedure

Alignment of the Model S1066AR Frequency Standard is the same as for the S1065AR except for the alignment of the 5 mc amplifier and crystal filter module. Adjustment procedures for this module require only that its tuned circuits be periodically peaked-up, since the bandpass of this circuit is controlled primarily by the "Q" of crystal Y301.

Adjust the module with the frequency standard operating normally and the input to the 5 mc amplifier Q301 derived from the internal oscillator in the frequency standard.

(1) Connect a 50 ohm resistive load to the 5 mc output connector at the rear of the unit.

(2) Connect an r-f voltmeter across the 50 ohm load.

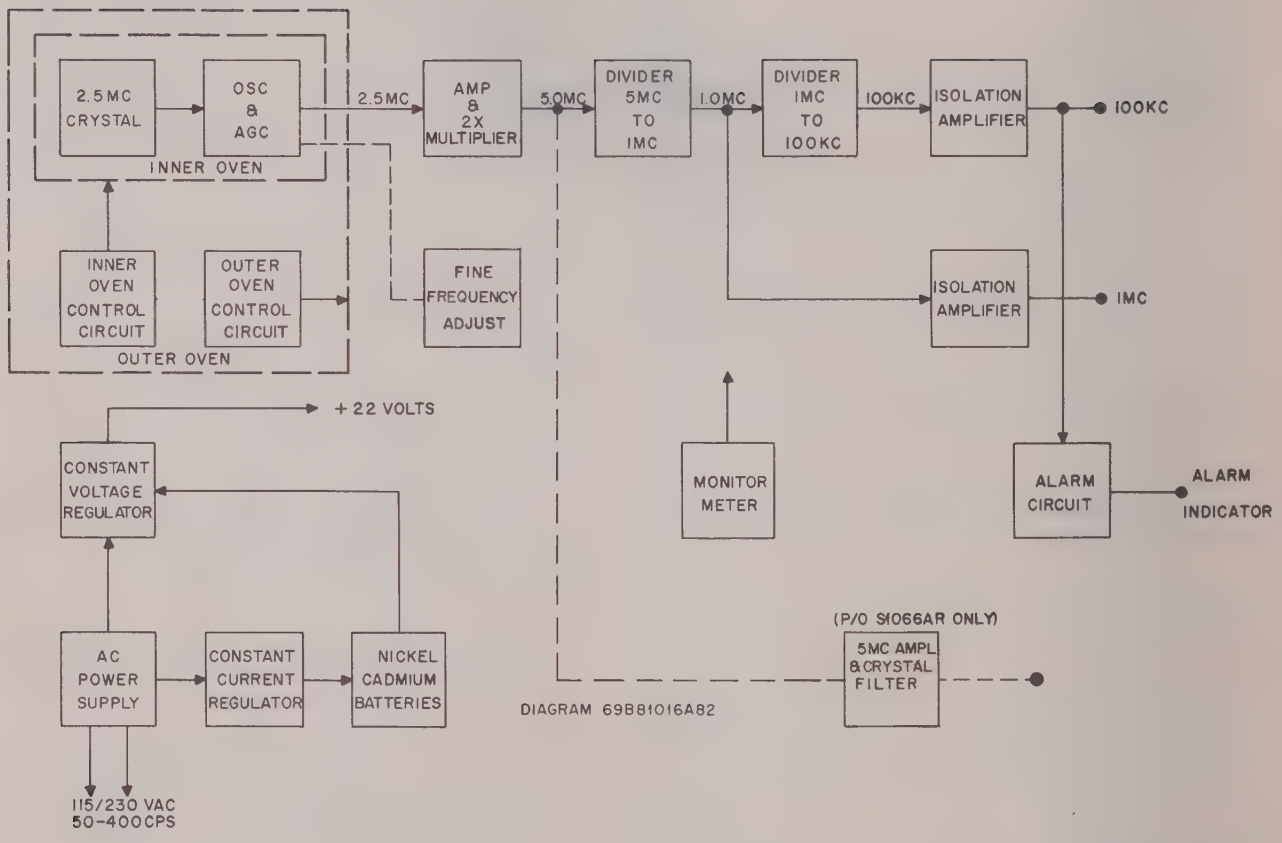
(3) Connect a jumper wire across resistor R321.

(4) Adjust L302 for a peak meter reading.

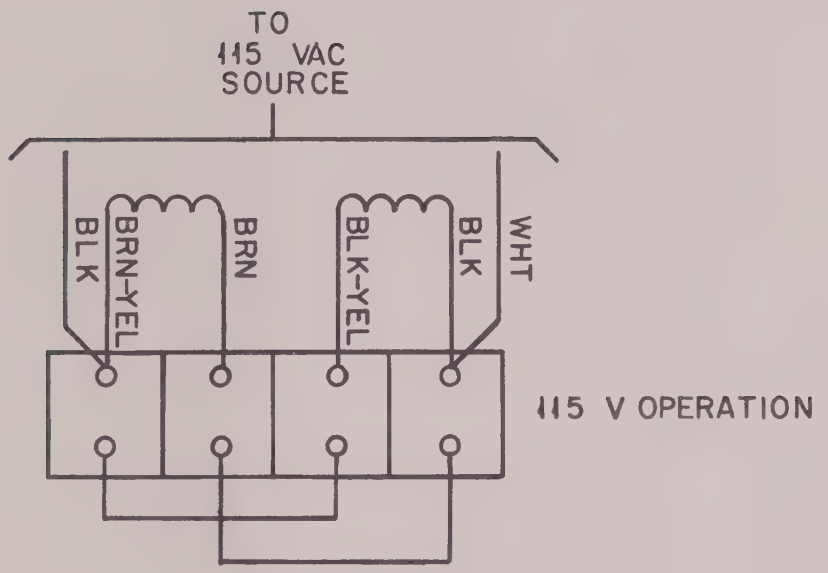
(5) Adjust capacitors C312, C320 and C323, in that order, for a peak meter reading.

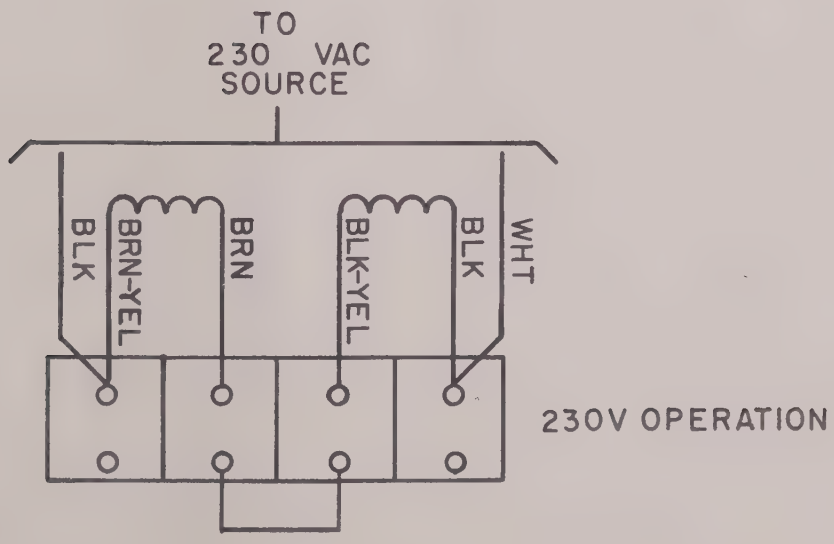
(6) Remove the jumper wire previously connected across R321.

(7) Adjust capacitor C323 for a peak meter reading. A minimum of 1.0 volt, rms should be obtained. Observe the output waveform (loaded) on an oscilloscope. If optimum wave shape is not seen, repeat steps (3) through (7).

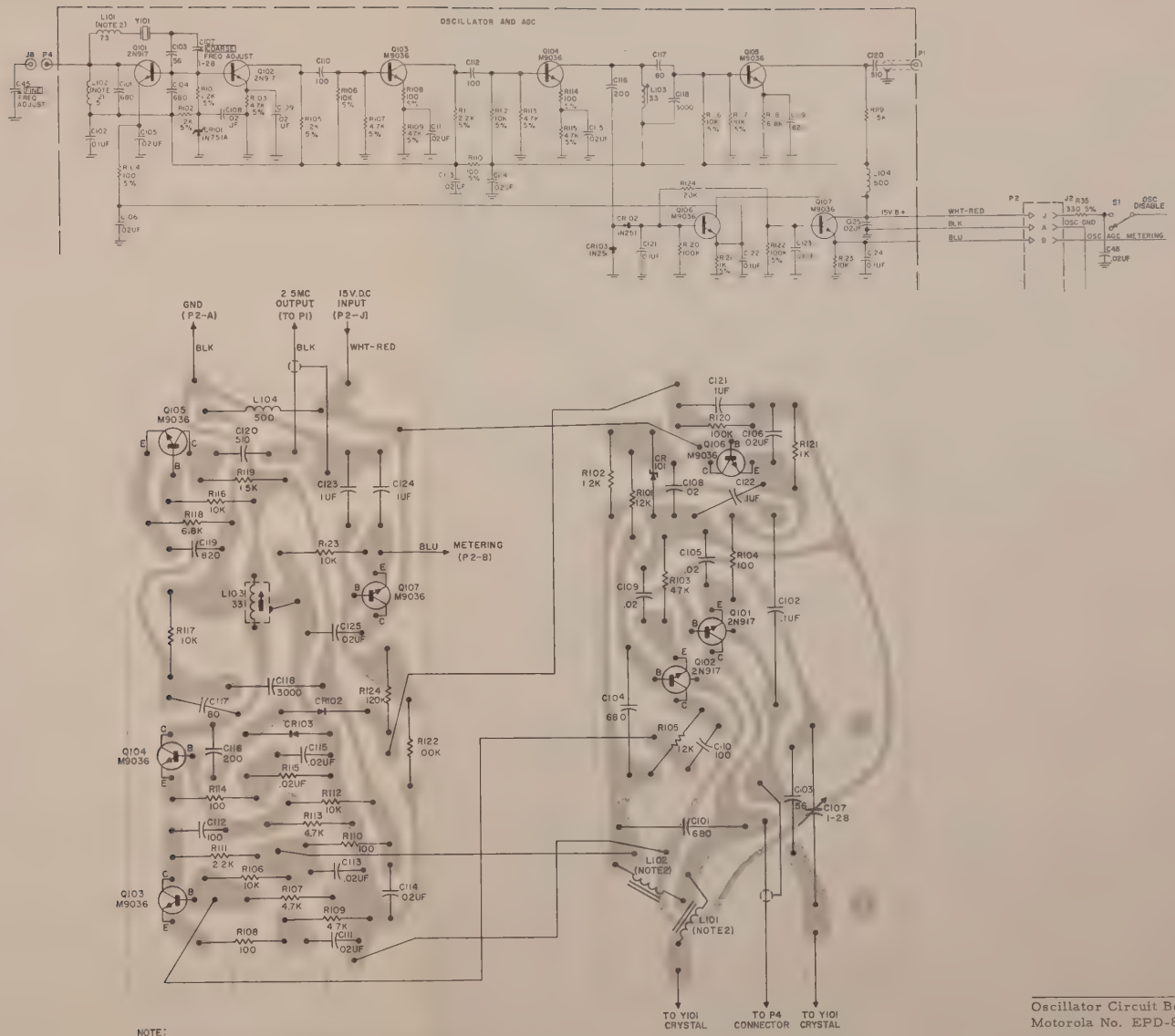


Models S1065AR/S1066AR Frequency Standard
Block Diagram
Motorola No. 69B81016A82-A



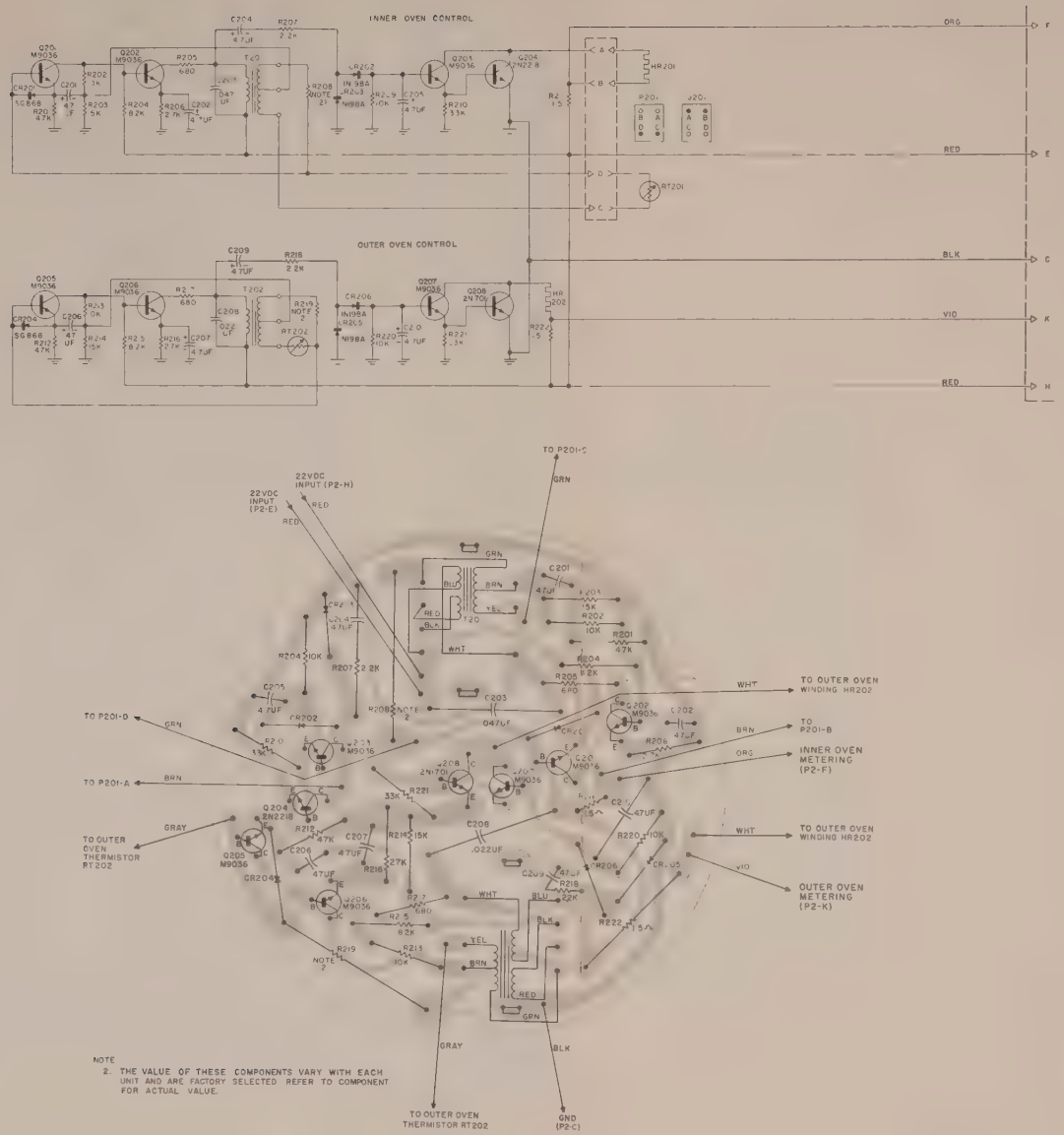


Primary Power Circuit Detail
Motorola No. AEPD-8391-A



NOTE:
2. THE VALUE OF THESE COMPONENTS VARY WITH EACH UNIT AND ARE FACTORY SELECTED. REFER TO COMPONENT FOR ACTUAL VALUE.

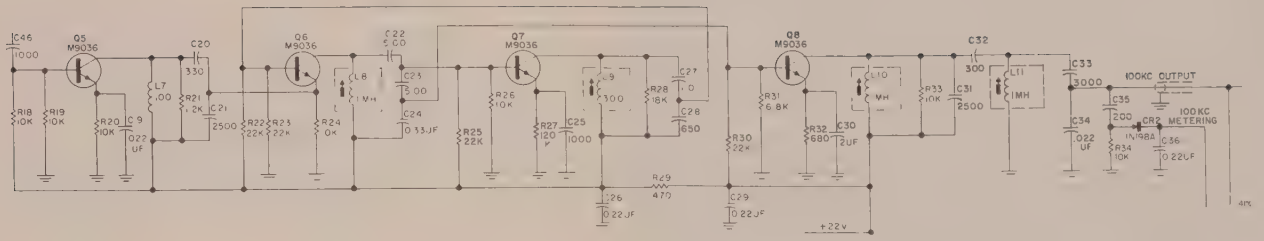
Oscillator Circuit Board Diagram
Motorola No. EPD-8392-A

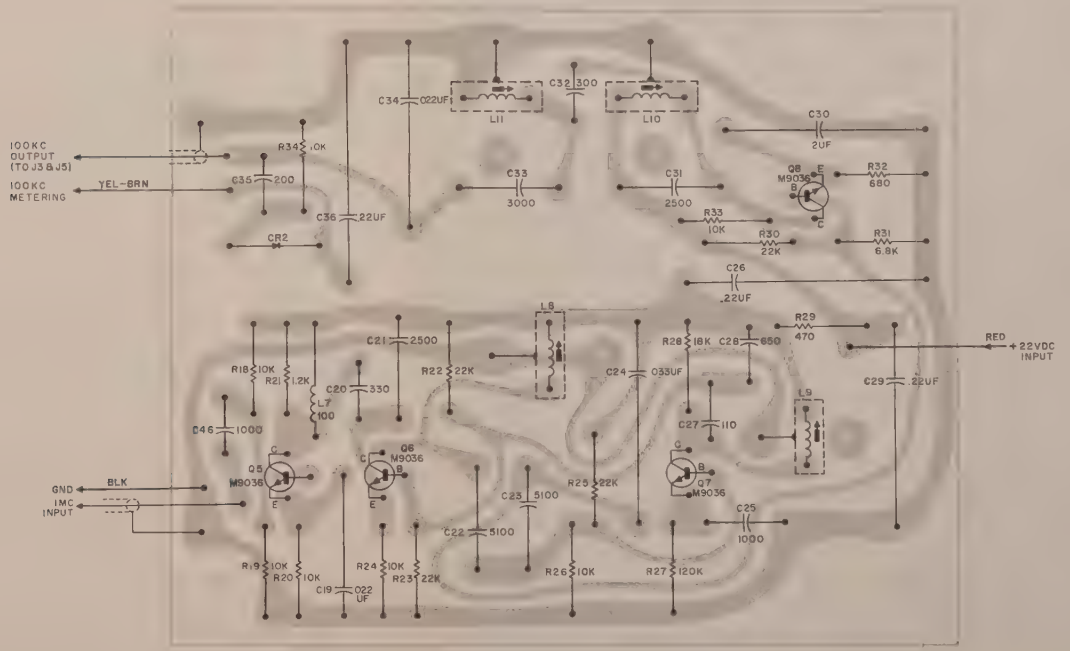


Inner and Outer Oven
Circuit Board Diagram
Motorola No. EPD-8395-O

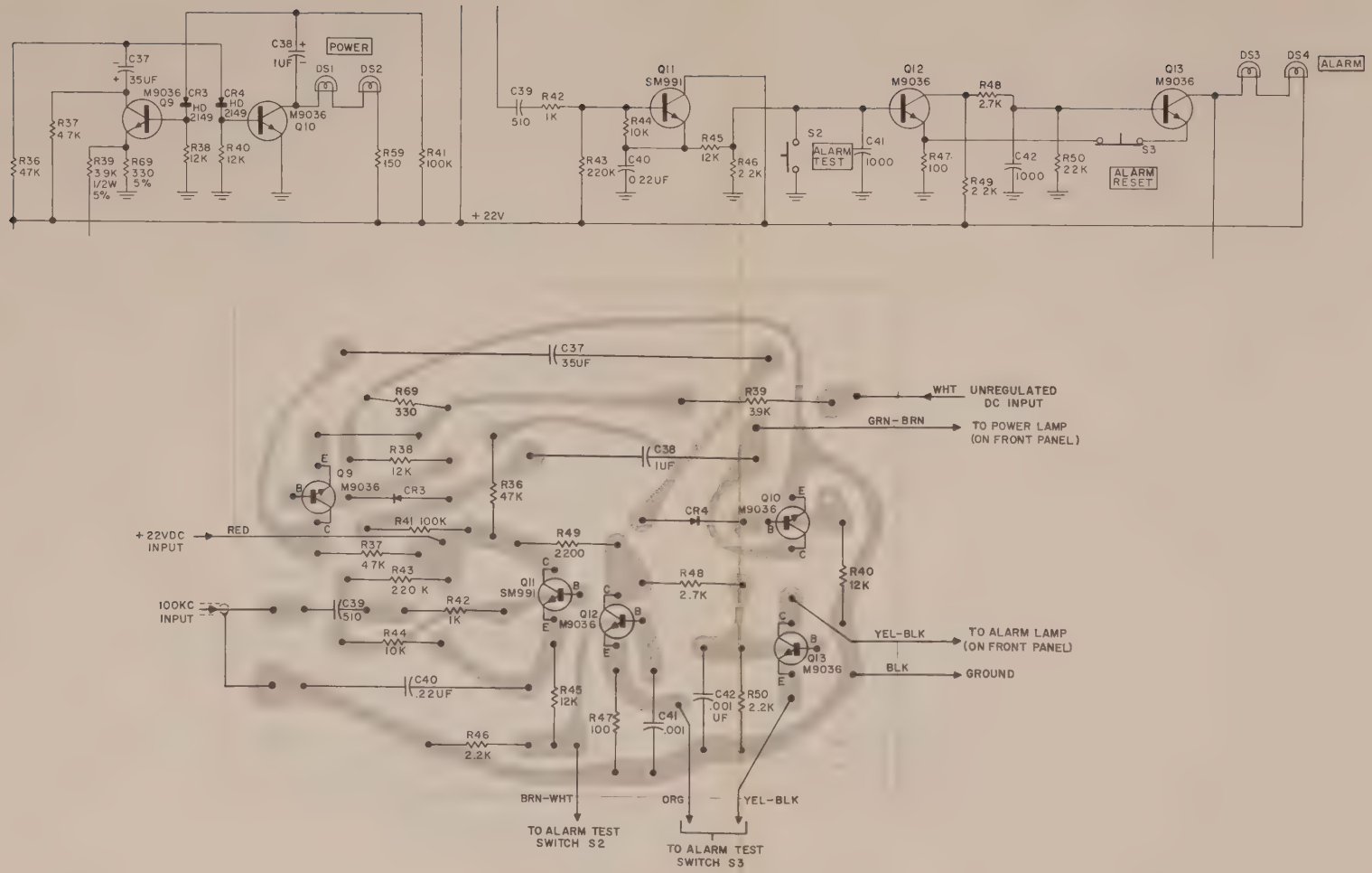
lr

CEPD-8396-O CEPD-8397-O



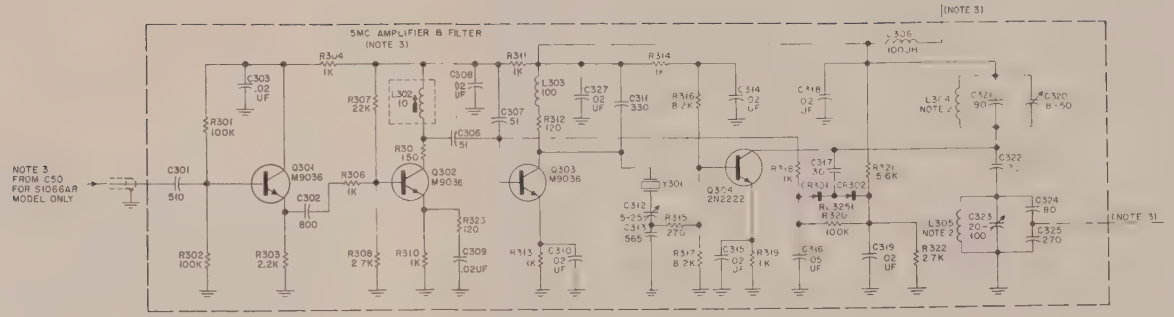


1 MC to 100 KC Divider
Circuit Board Diagram
Motorola No. EPD-8401-O



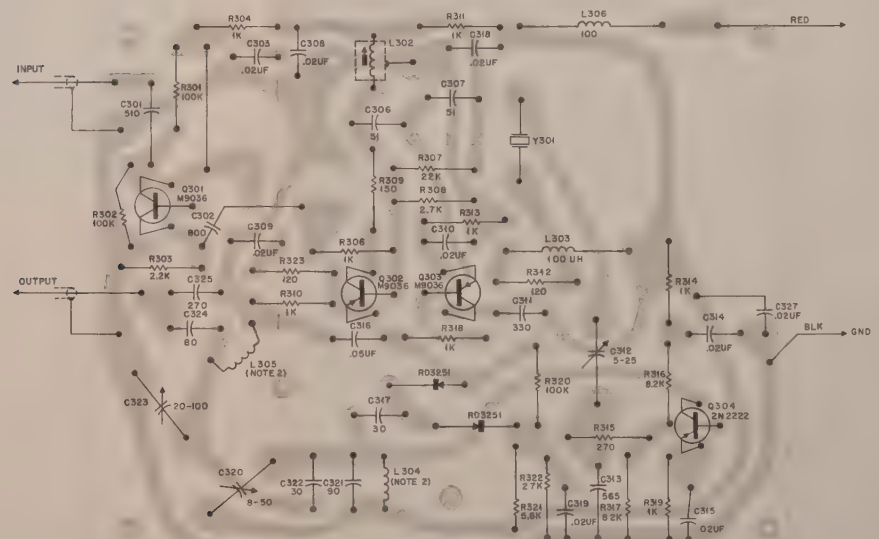
Power and Alarm
Circuit Board Diagram
Motorola No. EPD-8404-O

CEPD-8405-O CEPD-8406-A

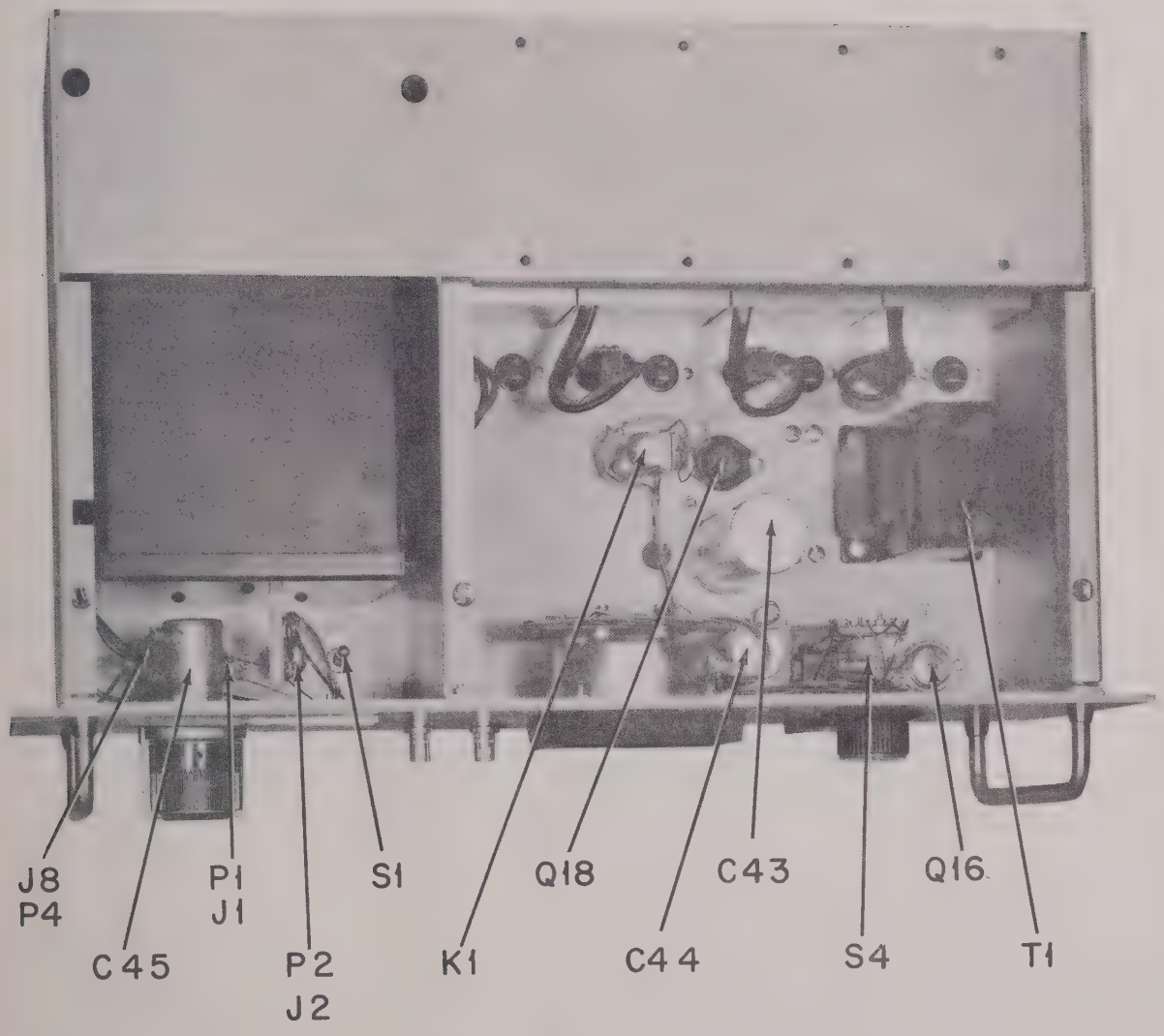


NOTES:

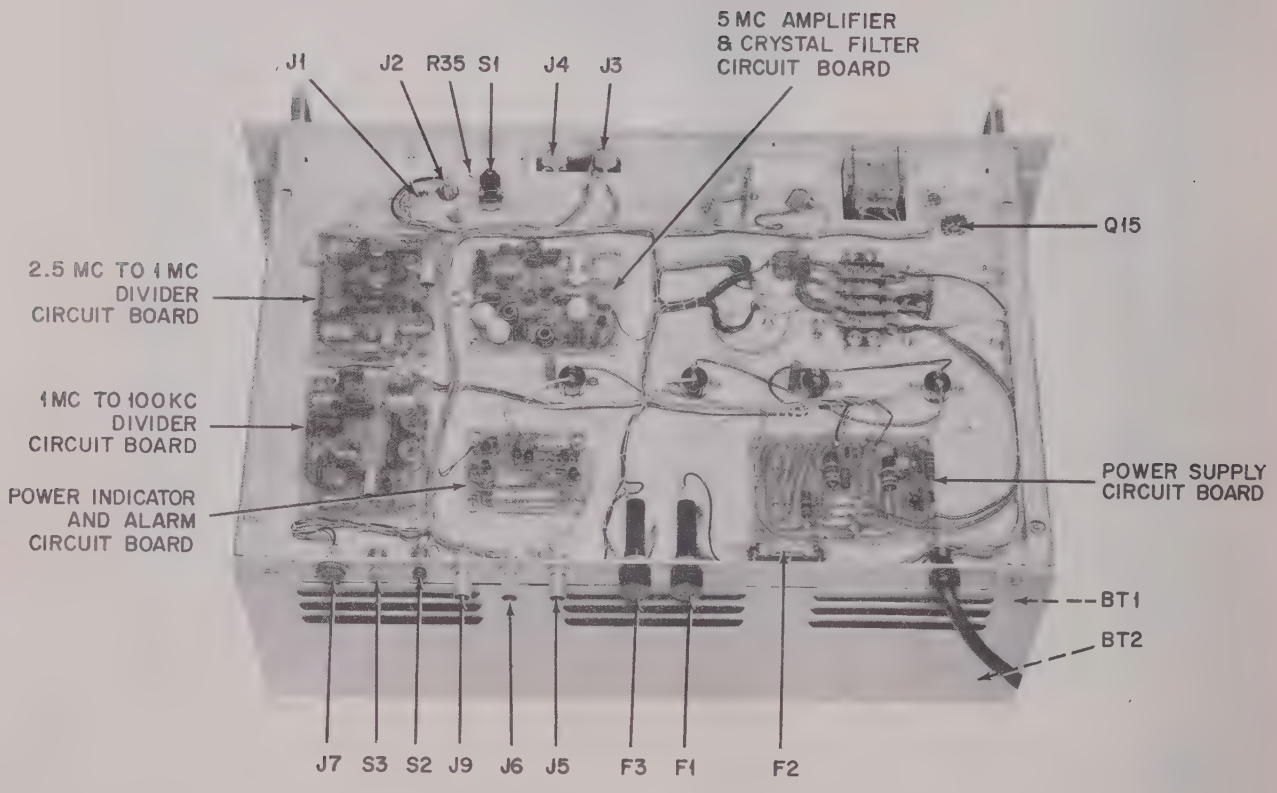
2. THE VALUE OF THESE COMPONENTS VARY WITH EACH UNIT AND ARE FACTORY SELECTED. REFER TO COMPONENT FOR ACTUAL VALUE.
3. THE 5MC AMPLIFIER AND FILTER AND DASHED LEADS ARE PART OF S1066AR FREQUENCY STANDARD ONLY.



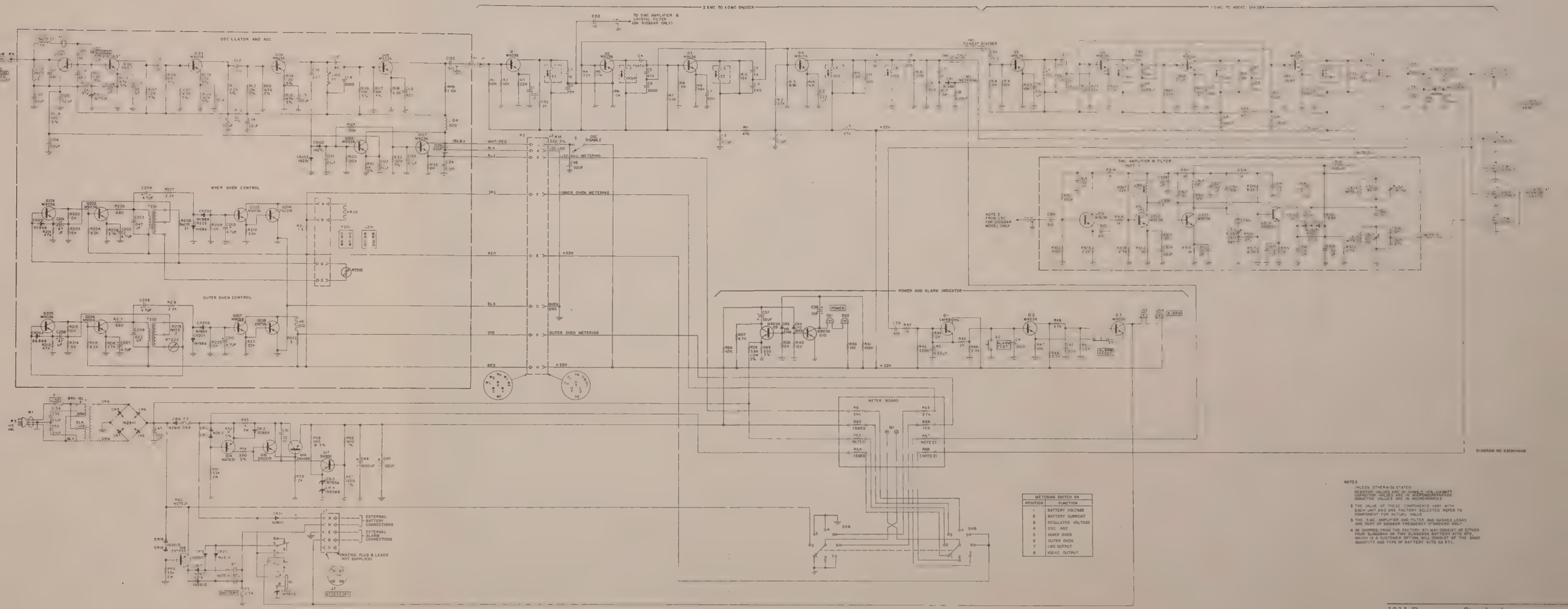
5 MC Amplifier & Crystal Filter
Circuit Board Diagram
Motorola No. EPD-8730-O



Parts Location Detail, Top View
Motorola No. AEPD-8411-O



Parts Location Detail, Bottom View
Motorola No. AEPD-8412-O


OSCILLATOR AND AGC
INNER OVEN CONTROL
OUTER OVEN CONTROL
2.5MC TO 10MC DIVIDER
10MC TO 100KC DIVIDER
5MC AMPLIFIER & FILTER
POWER AND ALARM INDICATOR
METER BOARD
METERING SWITCH S6
POSITION
FUNCTION
1 BATTERY VOLTAGE
2 BATTERY CURRENT
3 REGULATED VOLTAGE
4 OSC AGC
5 INNER OVEN
6 OUTER OVEN
7 1 MC OUTPUT
8 100 KC OUTPUT
EXTERNAL BATTERY CONNECTIONS
EXTERNAL ALARM CONNECTIONS
MATING PLUG & LEADS NOT SUPPLIED
NOTES
UNLESS OTHERWISE STATED
RESISTOR VALUES ARE IN OHMS, ± 10%, 1/4 WATT
CAPACITOR VALUES ARE IN MICROMICROFARADS
INDUCTOR VALUES ARE IN MICROHENRIES
2 THE VALUE OF THESE COMPONENTS VARY WITH EACH UNIT AND ARE FACTORY SELECTED REFER TO COMPONENT FOR ACTUAL VALUE
3 THE 5 MC AMPLIFIER AND FILTER AND DASHED LEADS ARE PART OF S1065AR FREQUENCY STANDARD ONLY
4 AS SHIPPED FROM THE FACTORY, B1 MAY CONSIST OF EITHER FOUR S1N6084A OR TWO S1N6083A BATTERY KITS, BT1, WHICH IS A CUSTOMER OPTION, WILL CONSIST OF THE SAME QUANTITY AND TYPE OF BATTERY KITS AS B1.

1011 Frequency Standard
(Models S1065AR and S1066AR)
Schematic and Intercabling Diagram
Motorola No. 63E81016A81-A

Replacement parts orders for components which do not show a Motorola part number must include the instrument model number, component reference symbol and the description which appears in the parts list.

PARTS LIST for Diagram 63E81016A81-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf; unless otherwise stated
C1, 12, 19, 34		.022 uf ±10%; 100 v
C2		
C3		19 ±5%, 300 v
C5	21K840713	120 ±5%; 500 v
C4, 6	21K82537B06	470 ±5%; 300 v
C7, 33, 118	21K863395	3000 ±2%; 500 v
C8, 11	21K873269	820 ±2%; 300 v
C9, 31, 105		0.1 uf, ±10%; 100 v
C10	21K847772	34 ±2%; 300 v
C13, 35, 116	21K840048	240 ±5%; 300 v
C14	21K840812	200 ±5%; 500 v
C15	21K848156	30 ±5%; 500 v
C16	21K859942	220 ±5%; 500 v
C17	21K863291	1500 ±2%; 500 v
C18, 26, 29, 36, 40	21K848272	21 ±5%; 300 v
C20	8K868594	0.22 uf ±10%; 100 v
C21, 31	21K873267	330 ±2%; 500 v
C22, 23	21K863296	2500 ±2%; 500 v
C24	21K874354	5100 ±5%; 300 v
C25	21K847601	.033 uf 10%; 100 v
C27	21K865445	1000 ±5%; 500 v
C28	21K848236	110 ±3%; 500 v
C30	23D82601A04	650 ±5%; 300 v
C32	21K859944	2 uf +250-10%; 25 v
C37	23D82601A13	300 ±5%; 500 v
C38	23D82601A16	35 uf +100-10%; 100 v
C39, 120	21K845214	1 uf +150-10%; 250 v
C41, 42	21K865923	510 ±5%; 300 v
C43	23K867695	1000 ±10%; 500 v
C44		1500 uf +100-10%; 50 v
C45		1000 uf
C46, 51	21K82537B16	adjustable: piston type
C47, 48, 105, 106, 108, 109, 111, 113, 114, 115, 125	21K832502	1000 ±5%, 300 v .02 uf +60-40%; 250 v
C50	21K859119	10 ±3%; 500 v
C52, 53	8K858371	0.1 uf ±10%, 400 v
C101, 104		680 ±5%; 300 v
C103		56 ±5%, 300 v
C107		adjustable: piston type; 1-28 uuf
C110, 112	21K850118	100 ±5%; 500 v
C117	21K847091	80 ±2%; 300 v
C121, 122, 123, 124	21C82372C01	0.1 uf +80-20%; 25 v
C201, 202, 204, 205, 206, 207, 209, 210	23K865137	4.7 uf ±20%; 25 v
C203		.047 uf, ±10%; 100 v
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR1, 2, 202, 203, 205, 206		silicon; 1N198A
CR3, 4	48C847274	germanium; HD2149
CR5 to 11, 15 to 21		silicon; 1N2610
CR12, 201, 204	48C82420C01	silicon; SG-868
CR13		silicon; zener; 1N750A
CR14		silicon; zener; 1N958B
CR22		silicon; zener; 1N966B
CR101		silicon; 1N751A
CR102, 103		silicon, 1N251
DS1, 2, 3, 4		LAMP, incandescent: 10 v; 40 ma; midget flanged; type 367
		CONNECTOR, receptacle:
		female, 9 contact
	7B855268	male; coaxial; type BNC
		female; 5 contact
		same as J3 (S1066AR only)
		RELAY
		26 v d-c; 2 form "C", coil res. 5000

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		COIL, RF: adjustable: unless otherwise stated
L1, 3, 103	SPC24B4139-1	33 uh
L2, 4, 6	24B82027E01	100 uh
L5		fixed; choke; 270 uh
L7		fixed; choke; 100 uh
L8, 10, 11		X542-1
L9	24B82027E02	300 uh
L101		(factory-selected)
L102		(factory-selected)
L104		500 uh
		AMMETER:
M1		50 ua movement;
		CONNECTOR, plug:
P1, 4		female, coaxial, min.
P2		male; 9 contact
P3		3 contact; male; p/o W1
		TRANSISTOR: (NOTE)
Q1 to 10, 12, 13	48R869036	N-P-N; type M9036
Q103 to 107, Q201 to 203, Q205 to 207		
Q11, 17		N-P-N; type SM991
Q14		P-N-P; type HA7631
Q15	48R809044	P-N-P, type M9044
Q16		N-P-N, type 2N1489
Q18		P-N-P, type 2N2144A
Q204	48R869061	N-P-N, type 2N2218
Q208	48R869045	N-P-N, type M9045
		RESISTOR, fixed: ±10%; 1/4 w; unless otherwise stated
R1, 2, 5, 6, 8, 15, 17, 18, 19, 20, 24, 26, 33, 34, 44, 123, 202, 209, 213, 220	6K129225	10K
R3, 4, 7, 12, 22, 23, 25, 30	6K128685	22K
R9, 61	6K128684	5[illegible] ±5%
R10, 203, 214	6K127805	15K
R11, 29	6K127801	470
R13, 31, 118	6K128687	5.6K
R14, 32, 205, 217	6K128599	680
R16	6K129752	270
R21	6K129235	1.5K
R27, 124	6K128987	120K
R28	6K128904	1MEG
R35, 54, 69	6K129806	330 ±5%
R36	6K128902	47K
R37, 201, 212	6K127804	4.7K
R38, 40, 45, 55	6K129230	1.2K
R39	6R2024	3.9K ±5%, 1 w
R41, 122	6K129226	100K
R42	6K127802	1K
R43	6K129147	22.8K
R46, 49, 50, 207, 218	6K128689	2.2K
R47	6K129752	100
R48, 206, 216	6K128688	2.7K
R51, 59	6R2029	3.3K, 2 w
R52	6K129805	1K ±5%
R53, 211, 222	17A851523	1.5, 3 w
R56		[illegible]
R57		22K
R58	6R131738	560 ±5%; 1 w
R60		(factory-selected)
R62, 64		1.5 meg ±5%
R63		(factory-selected)
R65	6K129707	27K ±5%
R66	6K129887	12K ±5%
R67		(factory-selected)
R68		(factory-selected)
R70	6R6373	150, 1 w
R101, 102, 105		1.2K ±5%; special type
R103, 107, 109, 113, 115		4.7K ±5%
R104, 108, 110, 114		100 ±5%; special type
R106, 112, 116, 117		10K ±5%
R111		2.2K ±5%; special type
R119	6K127803	1.5K

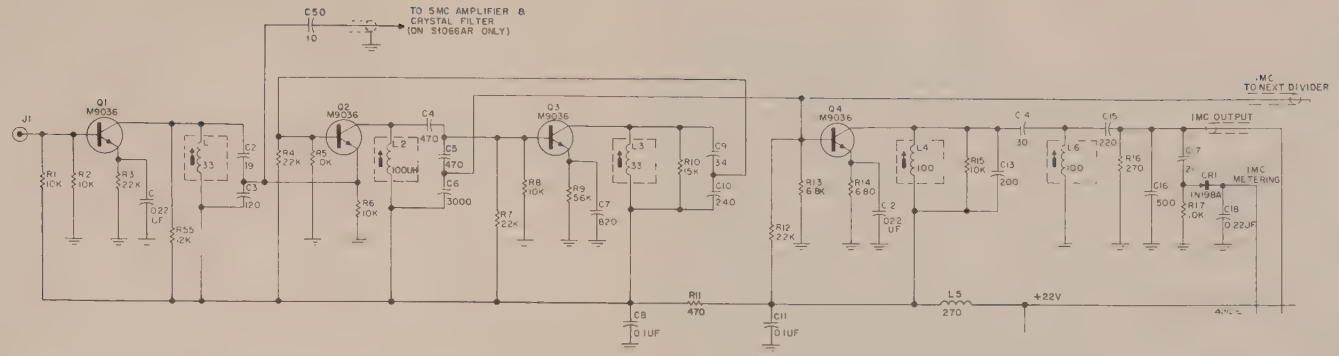
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R120		100K ±5%; special type
R121		1K ±5%; special type
R204, 215	6K128686	8.2K
R208		(factory-selected)
R210, 221	6K127807	33K
R214		(factory-selected)
		SWITCH,
S1	40A48297	toggle: spst
S2		push: spst; BLK
S3		push: spst; RED
S4	SPC40B3645	rotary: 2 section; consists of:
S4A		8 position; rear
S4B		8 position; front
		TRANSFORMER, power: 117 v; 50/60 cycle:
T1		pri: BLK, BLK sec: GRN, GRN
T201, 202	25C1858PC	audio
		CABLE ASSEMBLY, power:
W1		includes P3
		FUSEHOLDER:
XF1, 3		extractor post type
XF2		clip type
		CRYSTAL UNIT, quartz:
Y101		500 kc fundamental freq; 5th overtone operation (2.5 mc)

5 MC Multiplier & Filter

		CAPACITOR, fixed: uuf: unl stated
C301	21K845214	510 ±5%; 300 v
C302	21K840049	800 ±5%; 300 v
C303, 308, 309, 310, 314, 315, 316, 317	21K832502	.02 uf +60-40%; 250 v
C306, 307	21K840711	51 ±3%; 300 v
C311	21K874351	330 ±10%; 300 v
C312	20K859643	variable: 5-25
C313	21K863948	565 ±5%; 500 v
C318	21C82372C04	.05 uf +80-20%; 25 v
C319, 322	21K848156	30 ±5%; 500 v
C320	20B847059	variable: 8-50
C321	21K865941	90 ±2%; 300 v
C323	20K863152	variable: 20-100
C324	21K847091	80 ±2%; 300 v
C325	21K859178	270 ±5%; 300 v
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR301, 302	48C82617C01	RD3251
		COIL, RF:
L302	SP24B4139-2	variable: 10 uh ±5%
L303		160 uh
L304		toroidal (special)
L305		toroidal (special)
L306		100 uh
		TRANSISTOR: (NOTE)
Q301, 302, 303	48R869036	N-P-N; silicon; M9036
Q304		P-N-P; 2N2222
		RESISTOR, fixed: ±10%; 1/4 w;
R301, 302, 320	6K129226	100K
R303	6K128689	2.2K
R304, 306, 310, 311, 313, 314, 318, 319	6K127802	1K
R307	6K128685	22K
R308, 322	6K128688	2.7K
R309	6K129862	150
R312, 323	6K129617	120
R315	6K129775	270
R316, 317	6K128686	8.2K
R321	6K127804	4.7K
Y301		CRYSTAL UNIT, quartz: 5 MC operation

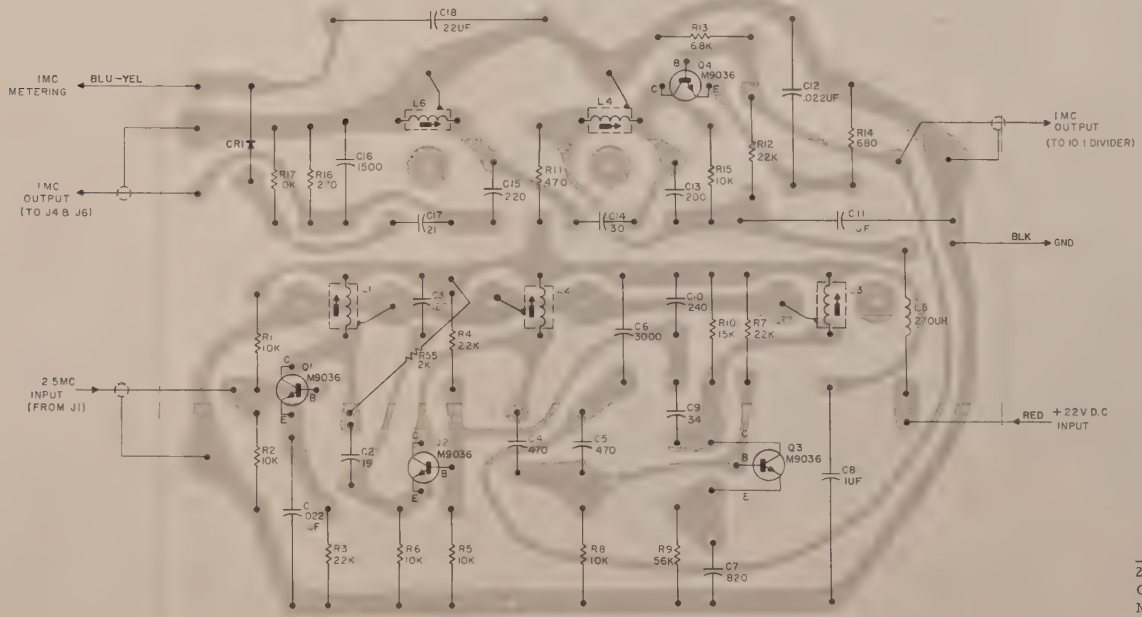
NOTE:

Replacement diodes and transistors must be ordered by Motorola reference and/or part number only for optimum performance.

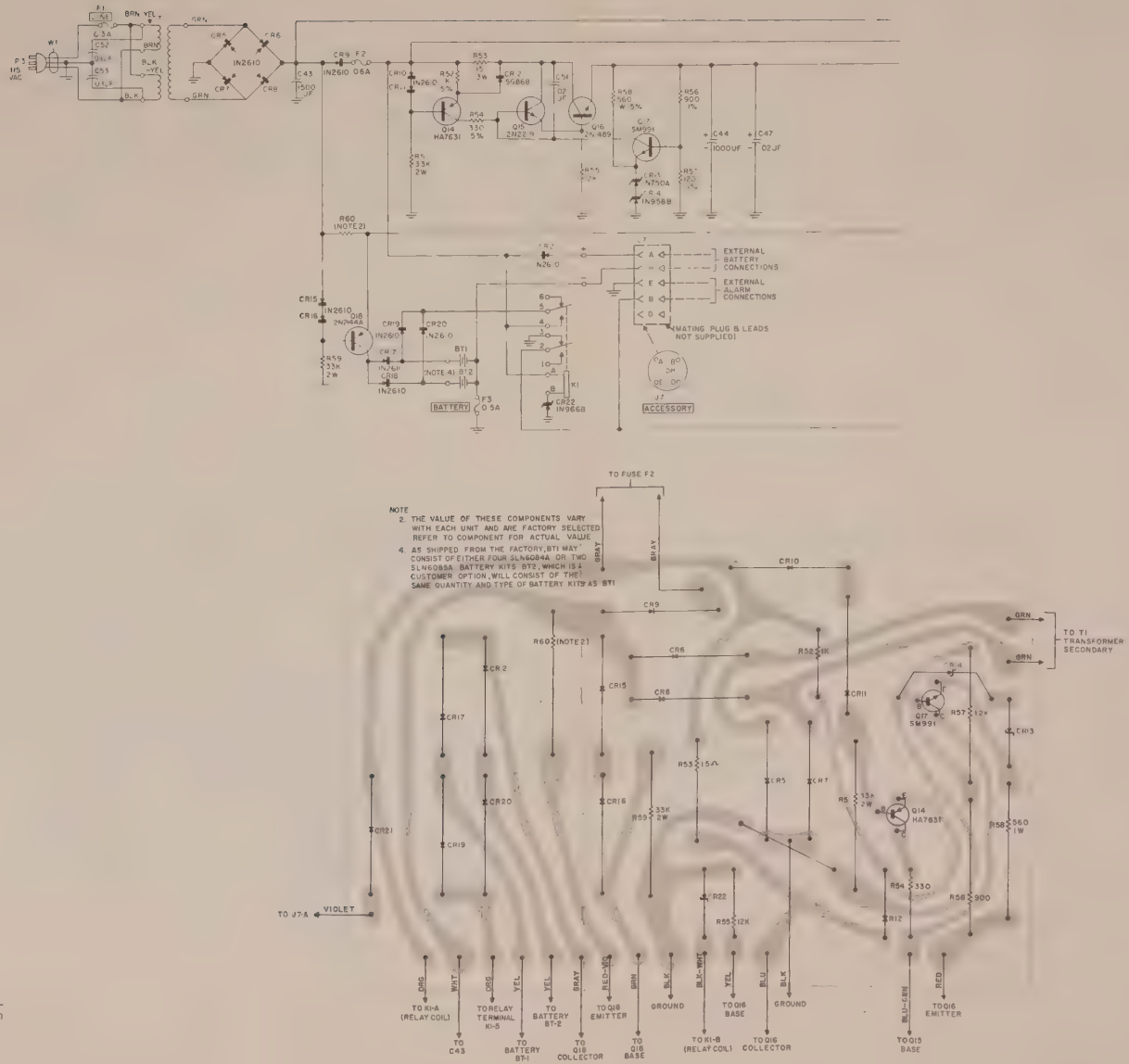


NOTES:

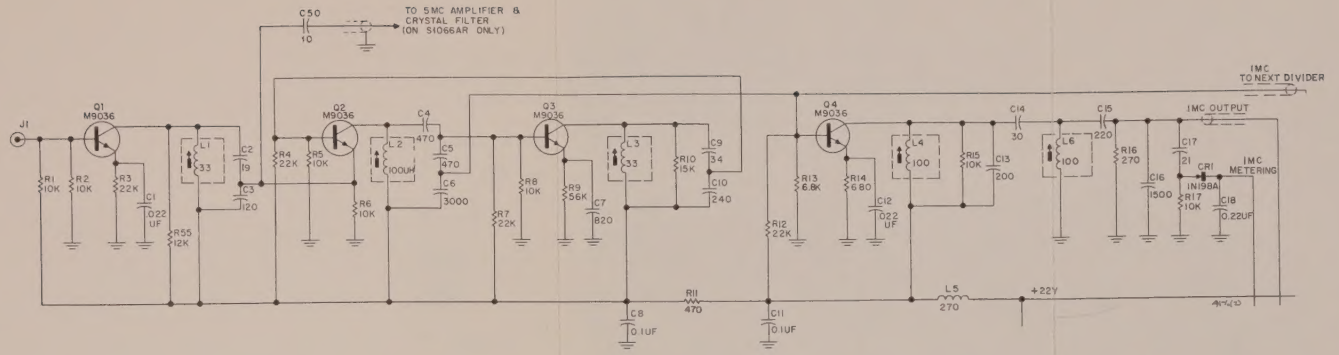
3. THE 5MC AMPLIFIER & FILTER AND DASHED LEADS ARE PART OF THE S1066AR FREQUENCY STANDARD ONLY.



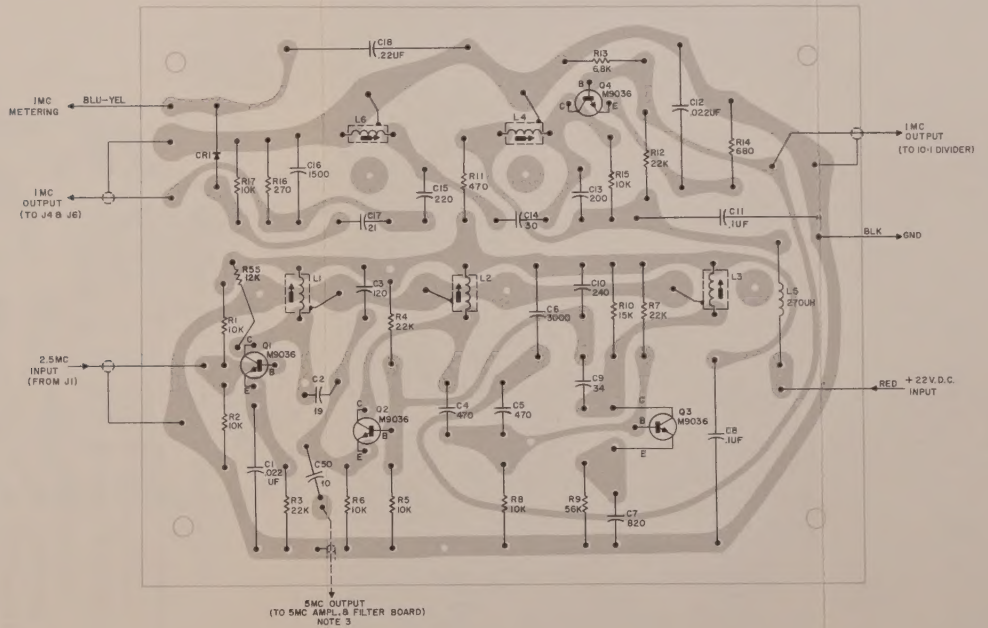
2.5 MC to 1 MC Divider
Circuit Board Diagram
Motorola No. EPD-8398-O



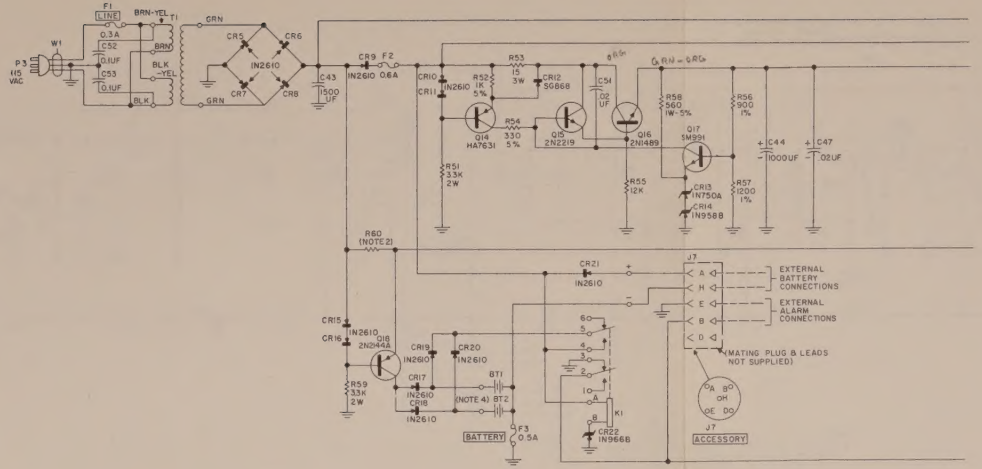
Power Supply Circuit Board Diagram
Motorola No. EPD-8407-O



NOTES:
3. THE 5MC AMPLIFIER & FILTER & DASHED LEADS ARE PART OF S1066AR FREQUENCY STANDARD ONLY.



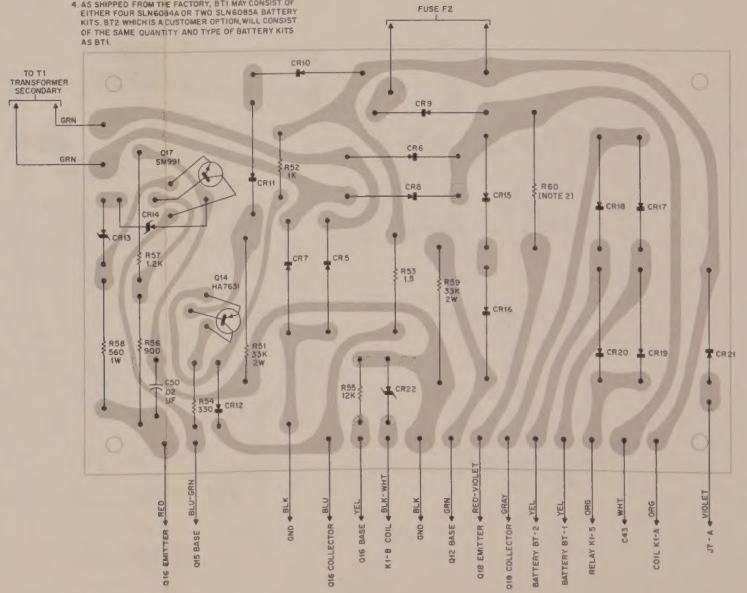
2.5 MC to 1 MC Divider
Circuit Board Diagram
Motorola No. EPD-8413-O



NOTES:

2. THE VALUE OF THESE COMPONENTS VARY WITH EACH UNIT AND ARE FACTORY SELECTED. REFER TO COMPONENT FOR ACTUAL VALUE.

4. AS SHIPPED FROM THE FACTORY, BT1 MAY CONSIST OF EITHER FOUR SLN6094A OR TWO SLN60854 BATTERY KITS. BT2 WHICH IS A CUSTOMER OPTION, WILL CONSIST OF THE SAME QUANTITY AND TYPE OF BATTERY KITS AS BT1.



Power Supply Circuit Board Diagram
Motorola No. EPD-8416-O